

Information Requests

WesternGeco 2D River Seismic Environmental Assessment

April 7th, 2003

1.1.1 Source: Mackenzie Valley Environmental Impact Review Board

To: Deh Cho First Nation (DCFN)

Reference

EAR, s. 8.5 Traditional Land Use, p.82-83

EAR, s. 8.5.1.3 Areas of Importance to the Deh Cho Region, p. 91

Terms of Reference Section

ToR s. 4.12 Cultural and Heritage Resources

“WG shall discuss the potential impacts of the proposed development on cultural and heritage resources along with potential mitigation methods and residual impacts. This discussion is to include, but not be limited to, a discussion of the significant areas of the Mackenzie River as designated by the Gwich’in, Sahtu and Deh Cho organizations, as well as the mitigation required to maintain the values that resulted in the identification of these areas. WG shall describe the spiritual significance of the Mackenzie River, and describe related cultural impacts and any proposed mitigations.”

Preamble

Mitigation aims to preserve the original value of valued components (VCs). There is an expectation that any mitigation of the potential effects of the river seismic preserve the original value of the VC. The importance of the Mackenzie River to the spirituality of the Deh Cho First Nation (DCFN) is expressed but the locations and meaning of these areas is poorly defined for impact assessment and potential mitigation purposes.

Request

The Board would appreciate the assistance of the DCFN in understanding the importance of its spiritual sites.

- a) What portion of the Mackenzie River is important to the spiritual well-being of the DCFN?
- b) Is the spiritual value of the Mackenzie River diminished or altered by river seismic exploration in a manner different from existing river traffic? If so, how is the spiritual value changed?

1.1.2 Source: Mackenzie Valley Environmental Impact Review Board

To: WesternGeco (WG)

Reference

EAR, s. 9.2.2.1 Physical Impacts, p. 108-114
Appendix III

Terms of Reference Section

ToR s. 4.9 Aquatic Resources, 4th bullet

“WG shall provide information on aquatic resources, mitigation measures and predicted residual impacts. [...] This section shall include, but not be limited to, a discussion of the following:

- [...] potential impacts of airguns on all life stages, including eggs and larvae, of fish species that are likely to be present in the Liard and Mackenzie Rivers at the time of the proposed seismic survey. Include consideration of behavioural effects and effects on anatomy and physiology of fish exposed to airguns (including effects on ear, lateral line, swim bladder and any other stress indicators) [...].

Preamble

The effects of sound on the sensory systems and on the overall physiology of fishes can have an immediate and a long-lasting impact on the survival of an individual animal and on a population of a species. Loud sounds can damage the sensory hair cells of the ears of terrestrial vertebrates. Since the sensory cells of the ears of fishes are very similar to those of terrestrial vertebrates, and since the mode of stimulation of the cells (mechanical bending of the cilia on the apical surface of these cells) is the same in all vertebrates, it is reasonable to conclude that loud sounds could also damage the sensory cells in the fish ear (and lateral line) and thereby impact hearing ability. McCauley et al. (2003) recently demonstrated through the use of scanning electron microscopy that hair cells were severely damaged after exposure to sounds from a seismic air gun.

It should be noted that in this study, and in earlier work by Enger (1981) and Hastings et al. (1996), as well as in work on terrestrial vertebrates, that damage could only be determined conclusively with the use of electron microscopy. Moreover, in order for any detailed structure of cells to be determined at the EM level the tissue must be fixed in very high quality (electron microscopy grade) fixatives – usually gluteraldehyde and/or paraformaldehyde. Buffered formalin (10%) is not a suitable fixative for analysis of detailed cell structure.

Therefore more information is needed relating to the methodology used by WG in its analysis of the impact of air gun sounds on the ears (and other systems) of fishes. To

evaluate WG's predictions of impacts, it is necessary to understand the basis for concluding, through the use of light microscopy, that there was no pathology to the ears and other systems of fishes as a result of air gun stimulation.

Request

Please provide detailed information about the pathology studies performed to permit the evaluation of the methods and results. In each case, provide data that enables the reviewer to compare animals at each of the distances from the source, as well as from the controls.

- a) Provide detailed methods on how the tissues were preserved and prepared for analysis. Were fish opened to allow fixative to penetrate into the internal tissues (Appendix III, p. 18)?
- b) Provide information on the methods used to analyze the material beyond the statement that light microscopy was used. How much of the tissue from each animal was studied, and what was the expertise of the individual(s) examining the tissue? Were the examinations done "blind" or did the observer know the treatment group from which the fish came?
- c) Justify the use of light microscopy as a method to analyze any potential damage to sensory hair cells, when this is generally only visible at the electron microscopy level.
- d) What was electron microscopy not performed?
- e) Provide the justification for the statements that there was no damage to the sensory cells of the lateral line and ear based upon light level histology of formalin preserved tissue (Appendix III, p. 35-36). Provide the data used to determine that there was no damage to sensory cells of the ear and the lateral line. Data should be provided for each fish evaluated, including controls, and should include high quality photographs or other images of the tissue that was evaluated. Any information about quantification used should also be provided.
- f) Were observations made on possible damage to the lateral line, and, if so, what were the results? Please provide detailed results including sufficient micrographs to support the conclusions reached.
- g) Were there any observations made on the cristae of the semicircular canals to determine if these vestibular organs were intact? If so, what were the results? If not, why were these not analyzed.
- h) Specify what is meant in Table VIa (Appendix III) "hairs/cilia visible and intact".
- i) Provide data on the results from each organ examined (as listed in Appendix III, p. 18) including images of exposed and control tissues.
- j) Was every animal examined for each tissue listed in Appendix III, p. 18? Provide data on each animal analyzed, including micrographs to support the conclusions. This should provide information on each organ mentioned in Appendix III, p. 18.
- k) What were the effects, if any, on the swim bladder? Describe how the swim bladder was evaluated and the results from the evaluation.
- l) In addition to the pathology described which involve sectioning of tissue, were there gross examinations of the swim bladder to determine whether there were gross impacts on this organ?

1.1.3 Source: Mackenzie Valley Environmental Impact Review Board

To: WesternGeco (WG)

Reference

EAR, s. 9.2.2.1 Physical Impacts, p. 108-114

Terms of Reference Section

ToR s. 4.9 Aquatic Resources, 4th bullet

“WG shall provide information on aquatic resources, mitigation measures and predicted residual impacts. [...] This section shall include, but not be limited to, a discussion of the following:

- [...] potential impacts of airguns on all life stages, including eggs and larvae, of fish species that are likely to be present in the Liard and Mackenzie Rivers at the time of the proposed seismic survey. Include consideration of behavioural effects and effects on anatomy and physiology of fish exposed to airguns (including effects on ear, lateral line, swim bladder and any other stress indicators) [...].

Preamble

One concern is that damage to sensory cells of the ear (and possibly the lateral line and cristae) take some time to show up as pathology, and potentially as impacts on behavior and physiology, as demonstrated by Hastings et al. (1996) and McCauley et al. (2003). Thus, holding fish for just a few hours or even a few days may not be sufficient to demonstrate the long-term impact on fish that could result from exposure to air guns. Similarly, the effects on eggs and larvae may not show up for a substantial time after stimulation and may, at first, be very subtle. Only later, as the larvae or embryo grows, would an impact on some systems show up.

Furthermore, whitefish are an important subsistence species. They were not considered in the caged fish tests.

Request

- a. Describe the basis for suggesting that there is no long-term impact on fish from air gun exposure.
- b. What differences might one expect in fishes that can swim away from the approaching source and fishes whose normal freight behavior is to stay in an area? What is the evidence, and how strong is it (regarding effects on both groups of fishes)?

- c. It is unclear how the comment that for marine species the lethal radius for eggs and larvae is under 3 m with sounds at 230 dB (page 5, 2nd paragraph from bottom) is related to the data, at least as discussed in the reference used, Gausland 2000. This is a review that makes a statement to this effect, but there are no data in this paper and no references are given for this statement. Provide scientific justification for this determination.
- d. Kostyuchenko (1973) worked with marine fishes, none of which are related to the species in the MacKenzie. However, it is notable that these investigators found damage to eggs at up to 20 m from the source. This study is cited as supporting little or no damage to fish eggs. However, review of the paper shows that there were minimal observations since eggs were not allowed to survive and develop. It is very possible that damage would not be manifest in the first day after stimulation, or that the initial damage would be sub-cellular and only show up in later development. It would be of value to understand how this paper (and that of Gausland, 2000) can be used to justify an argument that there is likely to be no impact on eggs.
- e. The issue of development discussed on page 8 needs some clarification. Even if the ear is fully developed late in the life stages of some fishes, the younger fish still have ears (and would have trouble orienting without them) and they also have lateral lines. It is potentially possible that there would be impact on the developing ear and lateral line. Please provide clarification.
- f. Can your interpretation of behavioural and physiological effects be extrapolated to whitefish?

1.1.4 Source: Mackenzie Valley Environmental Impact Review Board

To: WesternGeco (WG)

Reference

EAR, s. 9.2.2.1 Physical Impacts, p. 108-114
Appendix III

Terms of Reference Section

ToR s. 4.9 Aquatic Resources, 4th bullet

“WG shall provide information on aquatic resources, mitigation measures and predicted residual impacts. [...] This section shall include, but not be limited to, a discussion of the following:

- [...] potential impacts of airguns on all life stages, including eggs and larvae, of fish species that are likely to be present in the Liard and Mackenzie Rivers at the time of the proposed seismic survey. Include consideration of behavioural effects and effects on anatomy and physiology of fish exposed to airguns (including effects on ear, lateral line, swim bladder and any other stress indicators) [...].

Preamble

The behavior of fish in the cage could provide insight into the impact of the air guns on the animals. The indication that some fish were stunned (Appendix III, p. 38) suggests that at the closest point to the air guns, the sounds could potentially have resulted in physical harm to the fish.

Request

Please provide detailed data on the behavioral observations made in the cages of the fish that were ensouled and of the control fish.

- a. How were the behavioral observations made at the reference area (Appendix III, p17)? For how long were the observation periods? How many individuals made the observations? How easy was it to see into the water and could all fish be observed?
- b. How were these data quantified to demonstrate the presence or lack of behavioral impact? Include information about the behavioral observations on the controls. If quantitative data were gathered, provide a sample of the data and discuss how it was analyzed.
- c. Was there any evidence of vestibular disturbance in the form of fish swimming in tilted positions or any other position than the normal upright posture?

- d. Were behavioral observations made during the ensonification and, if so, how were these done? In cases where water was turbid (e.g., Appendix III, p. 33), were attempts made to determine the behavior of these larger fish in the presence of, and just after, ensonification? If not, why not? If observations were made, please describe the methods and detailed results.
- e. In Appendix III, p. 38, it is stated that fish in the cages with highest exposure levels were "briefly stunned." Explain the basis for this statement, and provide specific data to indicate how often this occurred, and the nature of the stunning (e.g., the behavior of the stunned fish). What was the duration of the period indicated as "briefly"?

1.1.5 Source: Mackenzie Valley Environmental Impact Review Board

To: WesternGeco (WG)

Reference

EAR, S. 7.2 Consultation, p.47
EAR, S. 9.2.9 Traditional Land Use, p. 125
Appendix V, Table V-1, p. V-1-23
Appendix V, Community-based monitor's reports

Terms of Reference Section

ToR s. 4.7 Public Consultation

“WG shall describe any concerns that were raised and detailing the responses to the concerns. Any unresolved concerns shall be highlighted along with a description of the intended course of action to resolve the concerns.”

Preamble

The most commonly cited potential environmental effects identified during public consultation related to changes in the success of traditional harvesting of fish; and physical effects of the seismic program on fish. In order to better understand these potential effects, WG implemented the 2002 Test Program. Community monitors were hired to assist with the 2002 Test Program by facilitating communication between communities passed by Test vessels and talking with fishers and other river users to relay any potential issues to WG. The EARR notes that there was more interest than concern in the proposed River Seismic program. Content analysis of all the community-based monitoring reports does not support this generalization.

Monitoring reports indicate concerns regarding potential effects on fish, fish harvesting and concerns about the effectiveness of monitoring to ascertain effects. The abundance of woody debris and the potential loss of dead fish to scavengers prior to sighting by monitors are cited as key challenges to ascertaining effects.

There is an apparent absence of a standardized approach for discussions with river users and for the preparation of the monitoring reports. This limits conclusions and increases the level of uncertainty associated with such conclusions. The monitoring reports lack detailed information about people in camps and owners of nets contacted during the monitoring program, as well as any observed changes in fish catch.

Request

Please respond to the following questions.

- a) Please provide details about those contacted during the 2002 Test Program and detailed minutes of these discussions. If possible, submit a complete list of individuals consulted.

- b) Please provide detailed minutes of meetings between community-based monitors and community residents after the passage of the Test Program, cited on p. 47 of the EARR.
- c) How will shore-based community monitoring be improved for the proposed *WG Mackenzie and Liard Rivers 2D Seismic Program 2003*?
- d) How was the confidence measure determined for potential impacts to fish and harvesting success?
- e) How would concerns regarding monitoring methods (e.g., woody debris, scavengers, lack of standardized approach) affect the confidence measures?

1.1.6 Source: Mackenzie Valley Environmental Impact Review Board

To: WesternGeco (WG)

Reference

EARR, s. 9.2.2.1 Physical Impacts, p. 108-114

Terms of Reference Section

ToR s. 4.9 Aquatic Resources, 2nd bullet

“WG shall provide information on aquatic resources, mitigation measures and predicted residual impacts. [...] This section shall include, but not be limited to, a discussion of the following:

- [...] species of fish present at the time of the seismic survey and their life stages, movement, migration patterns and habitat use [...].”

Preamble

The movement of fish as a migratory route and habitat for fish in the Mackenzie and the Liard Rivers is well-known. Few studies document the seasonal movements of fish species although local communities may be aware of these movement patterns.

Request

Please respond to the following questions.

- a) Can WG predict which species of fish will be in the Liard and Mackenzie River at the proposed time of the operation?

1.1.7 Source: Mackenzie Valley Environmental Impact Review Board

To: WesternGeco (WG)

Reference

EARR, s. 9.2.2.1 Physical Impacts, p. 110-111

Terms of Reference Section

ToR s. 4.9 Aquatic Resources, 3rd bullet

“WG shall provide information on aquatic resources, mitigation measures and predicted residual impacts. [...] This section shall include, but not be limited to, a discussion of the following:

- [...] general hearing information (bandwidth and thresholds) on Mackenzie River fish or related species (at all life stages) for which data are available in the literature [...].”

Preamble

On page 7, 2nd paragraph from the bottom of the response to the Deficiency Statement regarding material in Section 9.2.2.1 (p. 110-111 of the EARR) that there is little or no information on hearing abilities of freshwater fishes. This implies that the bulk of the data are for marine fishes. This assumption is incorrect – there is a reasonable body of data on freshwater fishes. There are no substantive hearing differences between freshwater and marine fishes. The basic auditory system is the same, and one should not differentiate between freshwater and marine fishes in discussions of hearing. There are data available on freshwater species.

Request

Please provide information, based upon what is known, of fish hearing that would indicate hearing abilities of Mackenzie River fishes, *at all life stages*.

1.1.8 Source: Mackenzie Valley Environmental Impact Review Board

To: WesternGeco (WG)

Reference

Appendix V, Table V-1, V-2, Nahanni Butte, March 5, 2002 – 2nd Response
Appendix V, Table V-1, V-3, Fort Good Hope, March 5, 2002 – 1st-4th Responses
Appendix V, Table V-1, V-9, Tsiigehtchic, March 7, 2002 – 5th Response
Appendix V, Table, V-18, Inuvik, May 9, 2002 – 3rd Response

Terms of Reference Section

ToR s. 4.2 Developer Identification and Performance Record, 5th bullet

“WG shall provide the following information:

- [...] an environmental performance record of the company and its contractors in conducting this type of Development in this region, in a similar setting and in other settings.”

Preamble

During public consultations, WG referred to previous river seismic work. These statements suggest direct involvement in or familiarity with river seismic work conducted in the Amazon, the Mackenzie Delta, Alabama, the North Saskatchewan and Humber rivers. Furthermore, the meeting in Tsiigehtchic (March 7, 2002) notes that WG has “done other river seismic with airguns for years, with fish monitors on board and have not seen stunned fish and have never had fish kills”.

Given the unprecedented scope and nature of this program in the Northwest Territories, the environmental performance of WG in similar projects is pertinent to this assessment. The paucity of studies on the physiological effects of seismic activity on fish elevates the value of anecdotal reports from fish monitors in the determination of the magnitude and significance of impacts. Previous river seismic experience may have a bearing on the evaluation of potential impacts.

Request

Please respond to the following questions.

- a) Can WG identify *all* river seismic programs implemented?
- b) Can WG describe the seismic technologies used in the river seismic programs identified in *question (a)* and explain the extent to which these programs are relevant to this EAR?
- c) Can WG provide the fish monitoring protocol and any results obtained from previous river seismic programs?